

# HCPL-M700/HCPL-M701

Small Outline, 5 Lead, Low Input Current, High Gain Optocouplers



## Data Sheet



### Description

These small outline, low input current, high gain optocouplers are single channel devices in a five lead miniature footprint. They are electrically equivalent to the following Avago optocouplers:

The SO-5 JEDEC registered (MO-155) package outline does not require “through holes” in a PCB. This package occupies approximately one-fourth the footprint area of the standard dual-in-line package. The lead profile is designed to be compatible with standard surface mount processes.

These high gain series opto-couplers use a Light Emitting Diode and an integrated high gain photo-detector to provide extremely high current transfer ratio between input and output. Separate pins for the photodiode and output stage results in TTL compatible saturation voltages and high speed operation. Where desired the  $V_{CC}$  and  $V_O$  terminals may be tied together to achieve conventional photo-darlington operation.

The HCPL-M701 is for use in CMOS, LSTTL or other low power applications. A 400% minimum current transfer ratio is guaranteed over a 0-70°C operating range for only 0.5 mA of LED current.

The HCPL-M700 is designed for use mainly in TTL applications. Current Transfer Ratio is 300% minimum over 0-70°C for an LED current of 1.6 mA [1 TTL Unit Load (U.L.)]. A 300% CTR enables operation with 1 U.L. out with a 2.2 k $\Omega$  pull-up resistor.

Selection for lower input currents down to 250  $\mu$ A is available upon request.

### Features

- Surface mountable
- Very small, low profile JEDEC registered package outline
- Compatible with infrared vapor phase reflow and wave soldering processes
- High current transfer ratio: 2000%
- Low input current capability: 0.5 mA
- TTL compatible output:  $V_{OL} = 0.1$  V
- Guaranteed ac and dc performance over temperature: 0°C to 70°C
- High output current: 60 mA
- Recognized under the component program of U.L. (file No. E55361) for dielectric withstand proof test voltage of 3750 Vac, 1 minute
- Lead free option “-000E”

### Applications

- Ground isolate most logic families: TTL/TTL, CMOS/TTL, CMOS/CMOS, LSTTL/TTL, CMOS/LSTTL
- Low input current line receiver
- EIA RS232C line receiver
- Telephone ring detector
- ac line voltage status indicator: low input power dissipation
- Low power systems: ground isolation

| SO-5 Package | Standard DIP | SO-8 Package |
|--------------|--------------|--------------|
| HCPL-M700    | 6N138        | HCPL-0700    |
| HCPL-M701    | 6N139        | HCPL-0701    |

**CAUTION:** The small device geometries inherent to the design of this bipolar component increase the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.

## Ordering Information

HCPL-M700 and HCPL-M701 are UL Recognized with 3750 V<sub>rms</sub> for 1 minute per UL1577 and are approved under CSA Component Acceptance Notice #5, File CA 88324.

| Part Number | Option         |                    | Package | Surface Mount | Gull Wing | Tape & Reel | Quantity      |
|-------------|----------------|--------------------|---------|---------------|-----------|-------------|---------------|
|             | RoHS Compliant | Non RoHS Compliant |         |               |           |             |               |
| HCPL-M700   | -000E          | No option          | SO-5    |               |           |             | 100 per tube  |
| HCPL-M701   | -500E          | # 500              |         | X             | X         | X           | 1500 per reel |

To order, choose a part number from the part number column and combine with the desired option from the option column to form an order entry.

Example 1:

HCPL-M700-500E to order product of Mini-flat Surface Mount 5-pin package in Tape and Reel packaging with RoHS compliant.

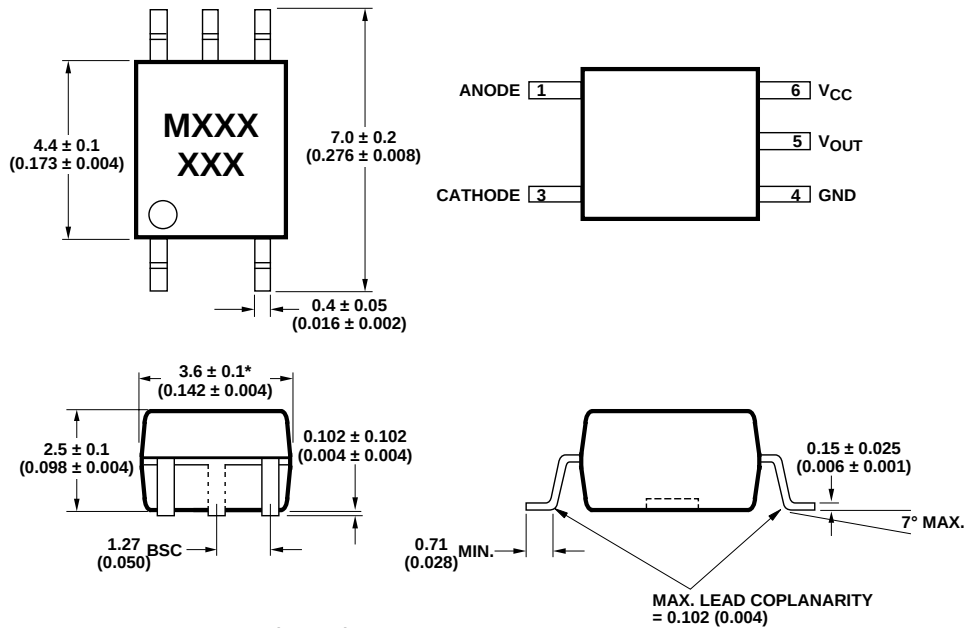
Example 2:

HCPL-M700 to order product of Mini-flat Surface Mount 5-pin package in tube packaging and non RoHS compliant.

Option data sheets are available. Contact your Avago sales representative or authorized distributor for information.

Remarks: The notation '#XXX' is used for existing products, while (new) products launched since 15<sup>th</sup> July 2001 and RoHS compliant option will use '-XXxE'.

## Outline Drawing (JEDEC MO-155)

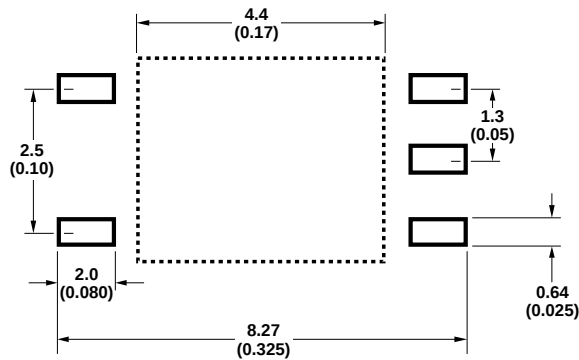


DIMENSIONS IN MILLIMETERS (INCHES)

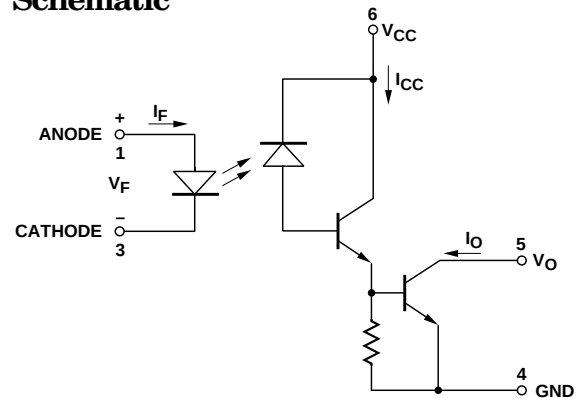
\* MAXIMUM MOLD FLASH ON EACH SIDE IS 0.15 mm (0.006)

NOTE: FLOATING LEAD PROTRUSION IS 0.15 mm (6 mils) MAX.

## Land Pattern Recommendation



## Schematic



## Absolute Maximum Ratings

(No Derating Required up to 85°C)

Storage Temperature ..... -55°C to +125°C

Operating Temperature ..... -40°C to +85°C

Average Input Current -  $I_F$  ..... 20 mA

Peak Input Current -  $I_F$  ..... 40 mA  
(50% duty cycle, 1 ms pulse width)

Peak Transient Input Current -  $I_F$  ..... 1.0 A  
( $\leq 1 \mu s$  pulse width, 300 pps)

Reverse Input Voltage -  $V_R$  ..... 5 V

Input Power Dissipation ..... 35 mW

Output Current -  $I_O$  (Pin 5) ..... 60 mA

Supply and Output Voltage -  $V_{CC}$  (Pin 6-4),  $V_O$  (Pin 5-4)

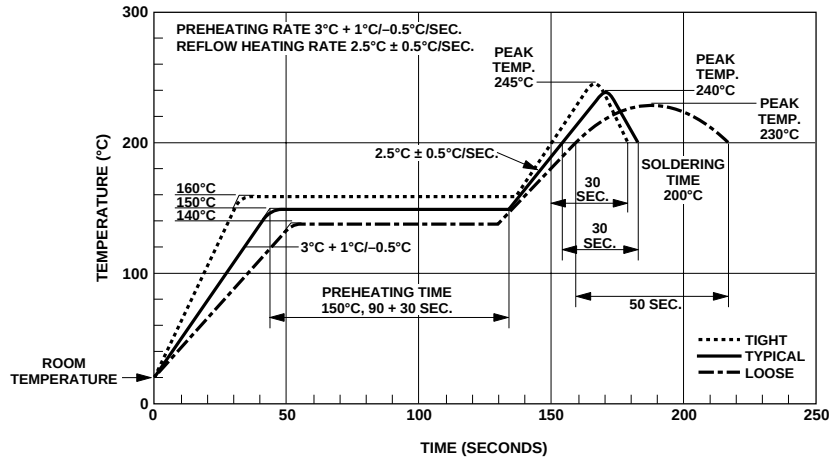
HCPL-M700 ..... -0.5 V to 7 V

HCPL-M701 ..... -0.5 V to 18 V

Output Power Dissipation ..... 100 mW

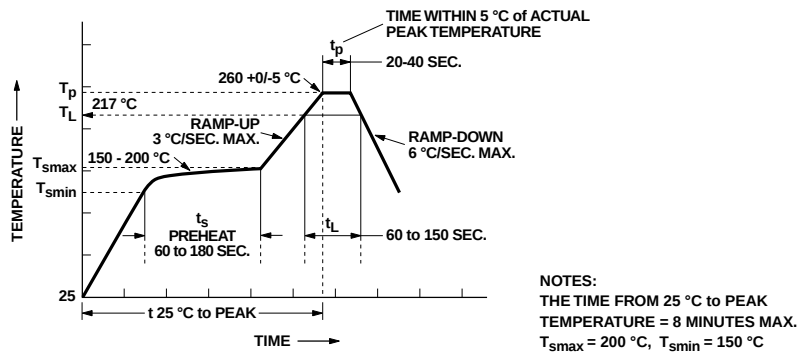
Infrared and Vapor Phase Reflow Temperature ..... see below

## Solder Reflow Thermal Profile



Note: Non-halide flux should be used.

## Recommended Pb-Free IR Profile



Note: Non-halide flux should be used.

## Insulation Related Specifications

| Parameter                              | Symbol | Value    | Units | Conditions                                         |
|----------------------------------------|--------|----------|-------|----------------------------------------------------|
| Min. External Air Gap (Clearance)      | L(IO1) | $\geq 5$ | mm    | Measured from input terminals to output terminals  |
| Min. External Tracking Path (Creepage) | L(IO2) | $\geq 5$ | mm    | Measured from input terminals to output terminals  |
| Min. Internal Plastic Gap (Clearance)  |        | 0.08     | mm    | Through insulation distance conductor to conductor |
| Tracking Resistance                    | CTI    | 175      | V     | DIN IEC 112/VDE 0303 Part 1                        |
| Isolation Group (per DIN VDE 0109)     |        | IIIa     |       | Material Group DIN VDE 0109                        |

## Electrical Specifications

Over recommended temperature ( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ) unless otherwise specified. (See note 6.)

| Parameter                                  | Symbol                  | Device HCPL- | Min. | Typ.*     | Max. | Units                | Test Conditions                                                                                                                                                                                                                 | Fig. | Note |
|--------------------------------------------|-------------------------|--------------|------|-----------|------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|
| Current Transfer Ratio                     | CTR                     | M701         | 400  | 2000      | 3500 | %                    | $I_F = 0.5\text{ mA}$ , $V_O = 0.4\text{ V}$ ,<br>$V_{CC} = 4.5\text{ V}$<br>$I_F = 1.6\text{ mA}$ , $V_O = 0.4\text{ V}$ ,<br>$V_{CC} = 4.5\text{ V}$                                                                          | 2, 3 | 1    |
|                                            |                         | M700         | 300  | 1600      | 2600 |                      | $I_F = 1.6\text{ mA}$ , $V_O = 0.4\text{ V}$ ,<br>$V_{CC} = 4.5\text{ V}$                                                                                                                                                       |      |      |
| Logic Low Output Voltage                   | $V_{OL}$                | M701         |      | 0.1       | 0.4  | V                    | $I_F = 1.6\text{ mA}$ , $I_O = 8\text{ mA}$ ,<br>$V_{CC} = 4.5\text{ V}$<br>$I_F = 5\text{ mA}$ , $I_O = 15\text{ mA}$ ,<br>$V_{CC} = 4.5\text{ V}$<br>$I_F = 12\text{ mA}$ , $I_O = 24\text{ mA}$ ,<br>$V_{CC} = 4.5\text{ V}$ | 1    |      |
|                                            |                         | M700         |      | 0.1       | 0.4  |                      | $I_F = 1.6\text{ mA}$ , $I_O = 24\text{ mA}$ ,<br>$V_{CC} = 4.5\text{ V}$                                                                                                                                                       |      |      |
| Logic High Output                          | $I_{OH}$                | M701         |      | 0.05      | 100  | $\mu\text{A}$        | $I_F = 0\text{ mA}$ ,<br>$V_O = V_{CC} = 18\text{ V}$                                                                                                                                                                           |      |      |
|                                            |                         | M700         |      | 0.1       | 250  |                      | $I_F = 0\text{ mA}$ ,<br>$V_O = V_{CC} = 7\text{ V}$                                                                                                                                                                            |      |      |
| Logic Low Supply Current                   | $I_{CCL}$               |              |      | 0.4       | 1.5  | mA                   | $I_F = 1.6\text{ mA}$ , $V_O = \text{Open}$ ,<br>$V_{CC} = 18\text{ V}$                                                                                                                                                         |      |      |
| Logic High Supply Current                  | $I_{CCH}$               |              |      | 0.01      | 10   | $\mu\text{A}$        | $I_F = 0\text{ mA}$ , $V_O = \text{Open}$ ,<br>$V_{CC} = 18\text{ V}$                                                                                                                                                           |      |      |
| Input Forward Voltage                      | $V_F$                   |              |      | 1.4       | 1.7  | V                    | $T_A = 25^\circ\text{C}$                                                                                                                                                                                                        | 4    |      |
|                                            |                         |              |      |           | 1.75 |                      | $I_F = 1.6\text{ mA}$                                                                                                                                                                                                           |      |      |
| Input Reverse Breakdown Voltage            | $BV_R$                  |              | 5    |           |      |                      | $I_R = 10\text{ }\mu\text{A}$                                                                                                                                                                                                   |      |      |
| Temperature Coefficient of Forward Voltage | $\Delta V_F/\Delta T_A$ |              |      | -1.8      |      | mV/ $^\circ\text{C}$ | $I_F = 1.6\text{ mA}$                                                                                                                                                                                                           |      |      |
| Input Capacitance                          | $C_{IN}$                |              |      | 60        |      | pF                   | $f = 1\text{ MHz}$ , $V_F = 0$                                                                                                                                                                                                  |      |      |
| Input-Output Insulation                    | $V_{ISO}$               |              | 3750 |           |      | $V_{RMS}$            | $RH \leq 50\%$ , $t = 1\text{ min}$ ,<br>$T_A = 25^\circ\text{C}$                                                                                                                                                               |      | 2, 3 |
| Resistance (Input-Output)                  | $R_{I-O}$               |              |      | $10^{12}$ |      | $\Omega$             | $V_{I-O} = 500\text{ V}_{DC}$                                                                                                                                                                                                   |      | 2    |
| Capacitance (Input-Output)                 | $C_{I-O}$               |              |      | 0.6       |      | pF                   | $f = 1\text{ MHz}$                                                                                                                                                                                                              |      | 2    |

\*All typicals at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ .

## Switching Specifications

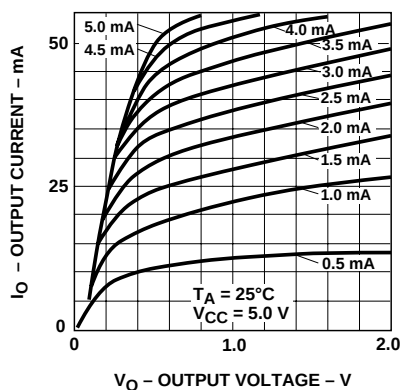
Over recommended temperature ( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ),  $V_{CC} = 5\text{ V}$ , unless otherwise specified.

| Parameter                                                          | Sym-<br>bol      | Device<br>HCPL- | Min.  | Typ.*  | Max. | Unit                   | Test Conditions                                                                              | Fig.       | Note |  |
|--------------------------------------------------------------------|------------------|-----------------|-------|--------|------|------------------------|----------------------------------------------------------------------------------------------|------------|------|--|
| Propagation<br>Delay Time<br>to Logic<br>Low at<br>Output          | $t_{\text{PHL}}$ | M701            |       | 25     | 75   | $\mu\text{s}$          | $T_A = 25^\circ\text{C}$ $I_F = 0.5\text{ mA}$ ,<br>$R_L = 4.7\text{ k}\Omega$               | 5, 6,<br>7 |      |  |
|                                                                    |                  |                 |       |        | 100  |                        |                                                                                              |            |      |  |
|                                                                    |                  |                 |       | 0.5    | 2    |                        | $T_A = 25^\circ\text{C}$ $I_F = 12\text{ mA}$ ,<br>$R_L = 270\ \Omega$                       |            |      |  |
|                                                                    |                  |                 |       |        | 3    |                        |                                                                                              |            |      |  |
|                                                                    |                  | M700            |       | 5      | 20   |                        | $T_A = 25^\circ\text{C}$ $I_F = 1.6\text{ mA}$ ,<br>$R_L = 2.2\text{ k}\Omega$               |            |      |  |
|                                                                    |                  |                 |       |        | 25   |                        |                                                                                              |            |      |  |
| Propagation<br>Delay Time<br>to Logic<br>High at<br>Output         | $t_{\text{PLH}}$ | M701            |       | 10     | 60   | $\mu\text{s}$          | $T_A = 25^\circ\text{C}$ $I_F = 0.5\text{ mA}$ ,<br>$R_L = 4.7\text{ k}\Omega$               | 5, 6,<br>7 |      |  |
|                                                                    |                  |                 |       |        | 90   |                        |                                                                                              |            |      |  |
|                                                                    |                  |                 |       | 1      | 10   |                        | $T_A = 25^\circ\text{C}$ $I_F = 12\text{ mA}$ ,<br>$R_L = 270\ \Omega$                       |            |      |  |
|                                                                    |                  |                 |       |        | 15   |                        |                                                                                              |            |      |  |
|                                                                    |                  | M700            |       | 10     | 35   |                        | $T_A = 25^\circ\text{C}$ $I_F = 1.6\text{ mA}$ ,<br>$R_L = 2.2\text{ k}\Omega$               |            |      |  |
|                                                                    |                  |                 |       |        | 50   |                        |                                                                                              |            |      |  |
| Common<br>Mode<br>Transient<br>Immunity at<br>Logic High<br>Output | $ CM_H $         |                 | 1,000 | 10,000 |      | $\text{V}/\mu\text{s}$ | $I_F = 0\text{ mA}$<br>$R_L = 2.2\text{ k}\Omega$<br>$ V_{CM}  = 10\text{ V}_{\text{p-p}}$   | 8          | 4, 5 |  |
| Common<br>Mode<br>Transient<br>Immunity at<br>Logic Low<br>Output  | $ CM_L $         |                 | 1,000 | 10,000 |      | $\text{V}/\mu\text{s}$ | $I_F = 1.6\text{ mA}$<br>$R_L = 2.2\text{ k}\Omega$<br>$ V_{CM}  = 10\text{ V}_{\text{p-p}}$ | 8          | 4, 5 |  |

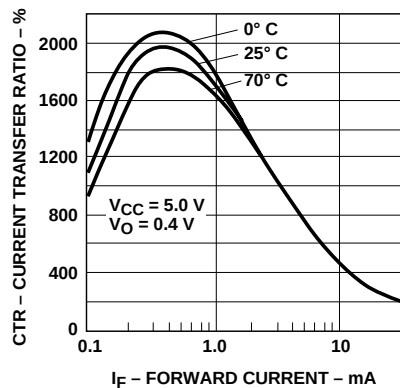
\*All typicals at  $T_A = 25^\circ\text{C}$ .

### Notes:

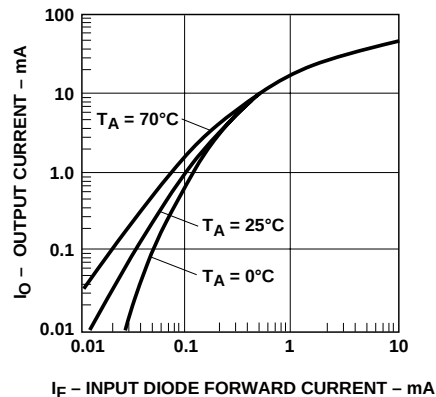
- dc CURRENT TRANSFER RATIO in percent is defined as the ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$ , times 100.
- Device considered a two terminal device: pins 1 and 3 shorted together, and pins 4, 5 and 6 shorted together.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 4500\text{ V}_{\text{RMS}}$  for 1 second (leakage detection current limit,  $I_{L-O} \leq 5\ \mu\text{A}$ ).
- Common transient immunity in a Logic High level is the maximum tolerable (positive)  $dV_{CM}/dt$  on the rising edge of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in a Logic High state (i.e.,  $V_O > 2.0\text{ V}$ ). Common mode transient immunity in a Logic Low level is the maximum tolerable (negative)  $dV_{CM}/dt$  on the falling edge of the common mode pulse signal,  $V_{CM}$ , to assure that the output will remain in a Logic Low state (i.e.,  $V_O < 0.8\text{ V}$ ).
- In applications where  $dV/dt$  may exceed  $50,000\text{ V}/\mu\text{s}$  (such as static discharge) a series resistor,  $R_{CC}$ , should be included to protect the detector IC from destructively high surge currents. The recommended value is  $R_{CC} = 220\ \Omega$ .
- Use of a  $0.1\ \mu\text{F}$  bypass capacitor connected between pins 4 and 6 is recommended.



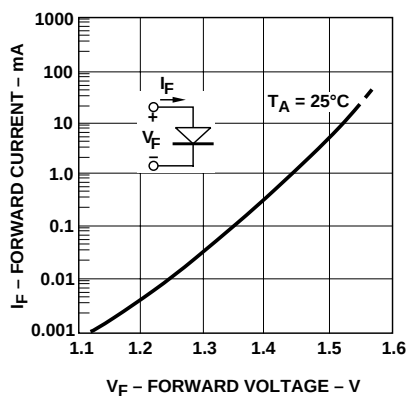
**Figure 1. dc Transfer Characteristics.**



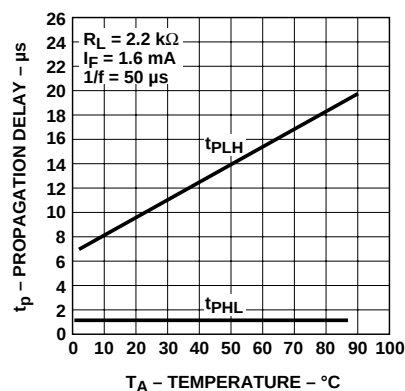
**Figure 2. Current Transfer Ratio vs. Forward Current.**



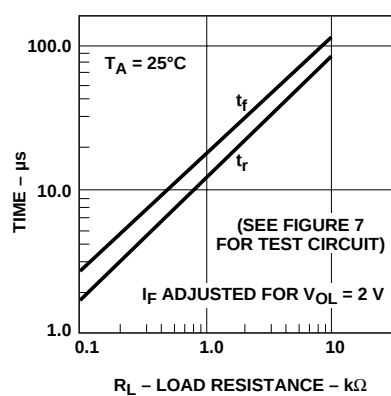
**Figure 3. Output Current vs. Input Diode Forward Current.**



**Figure 4. Input Diode Forward Current vs. Forward Voltage.**



**Figure 5. Propagation Delay vs. Temperature.**



**Figure 6. Non-Saturated Rise and Fall Times vs. Load Resistance.**

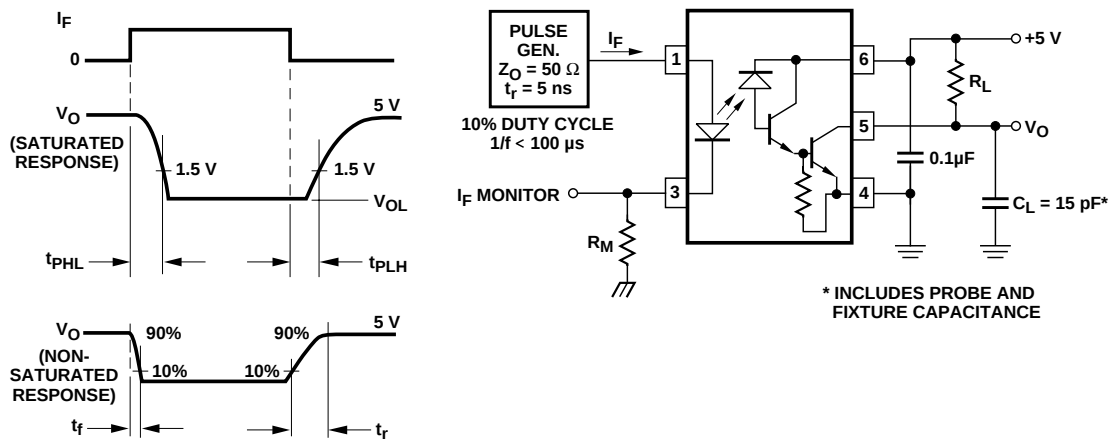


Figure 7. Switching Test Circuit.

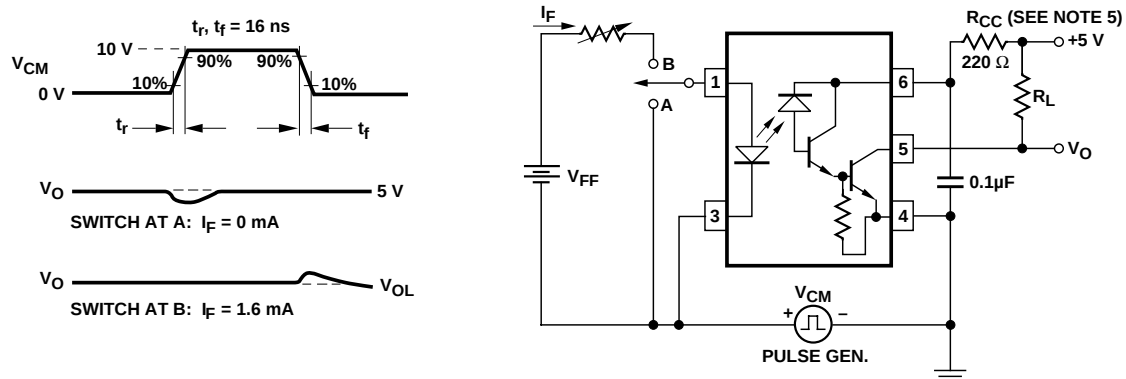


Figure 8. Test Circuit for Transient Immunity and Typical Waveforms.

For product information and a complete list of distributors, please go to our website: **[www.avagotech.com](http://www.avagotech.com)**

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